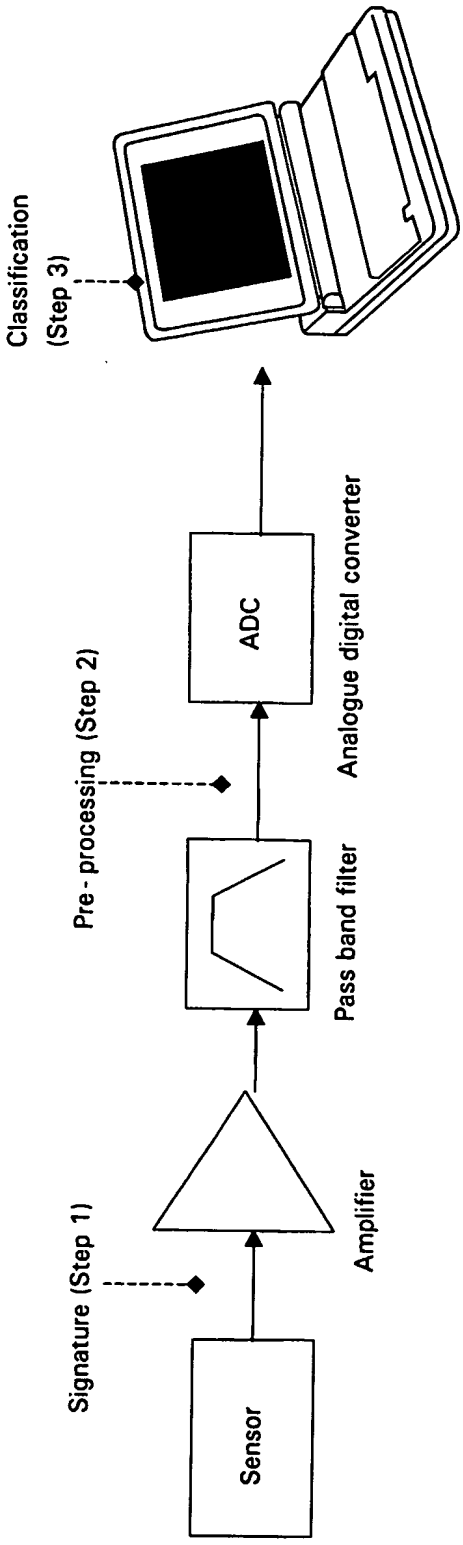
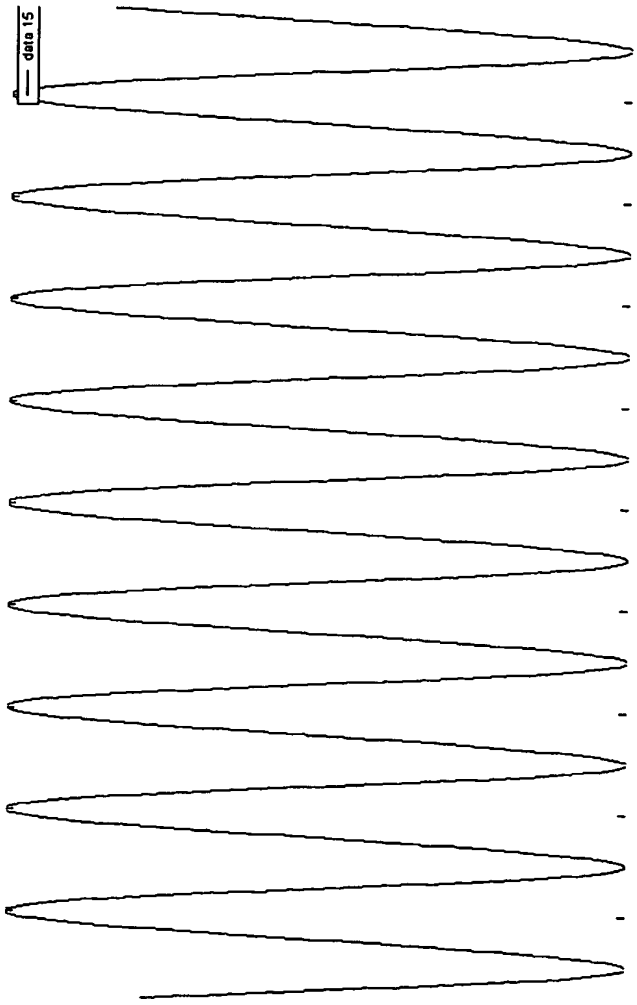

Classification
(Step 3)
ADC
Analogue digital converter
Pre - processing (Step 2)
Pass band filter
Amplifier
Signature (Step 1)
Sensor

Figure 1

Step 1 – Incoming signature from sensor (time domain)

Figure 2

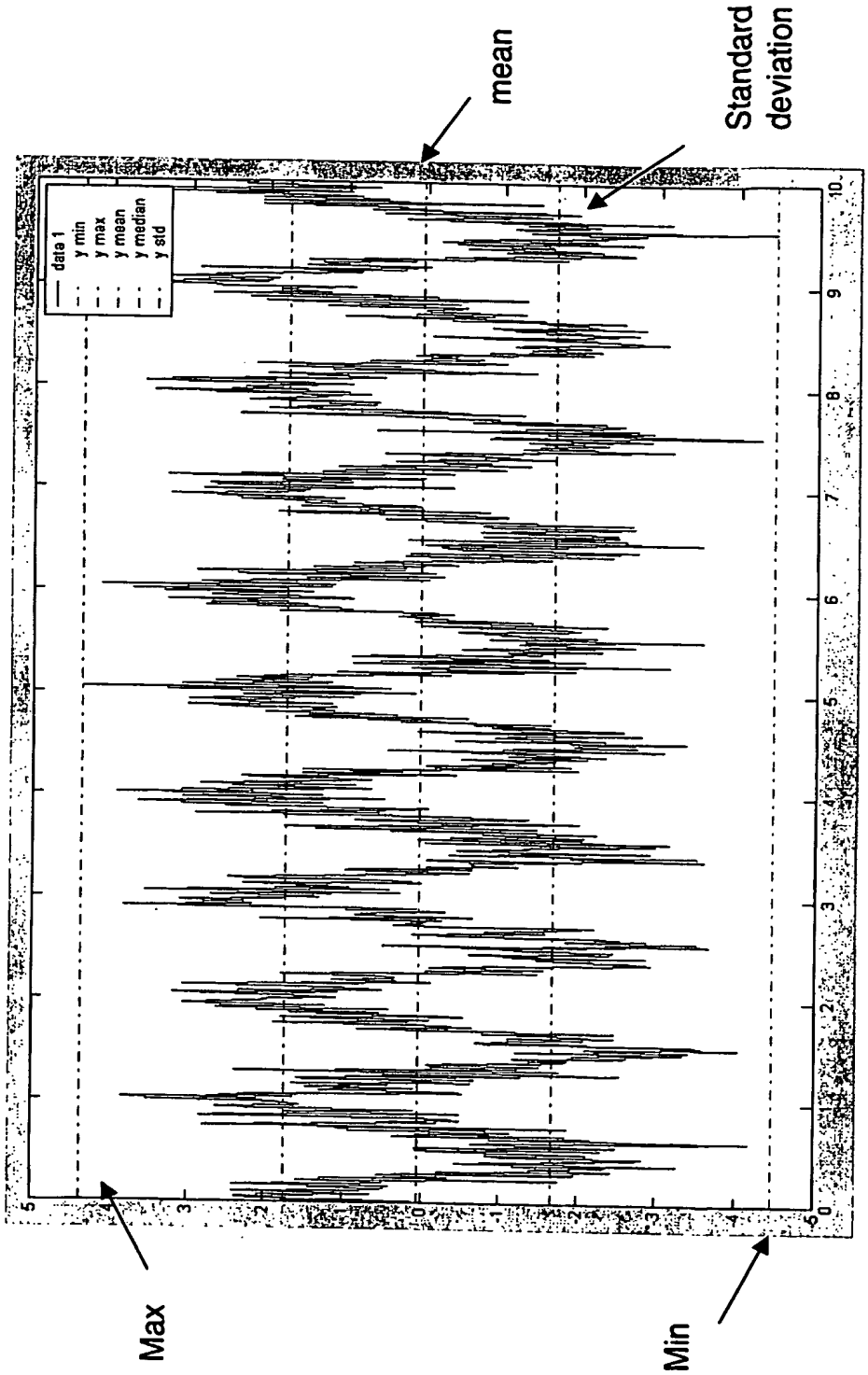


Step 2 – Filtered signature (time domain)

Figure 3

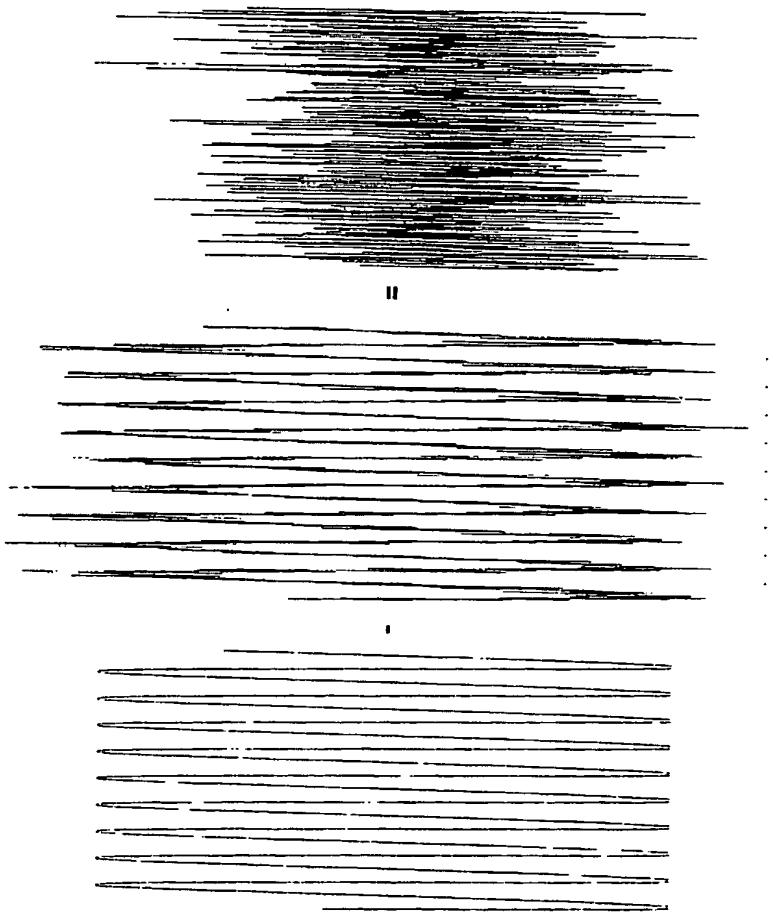
Step 3 – Filtered signature (frequency domain)

Figure 4



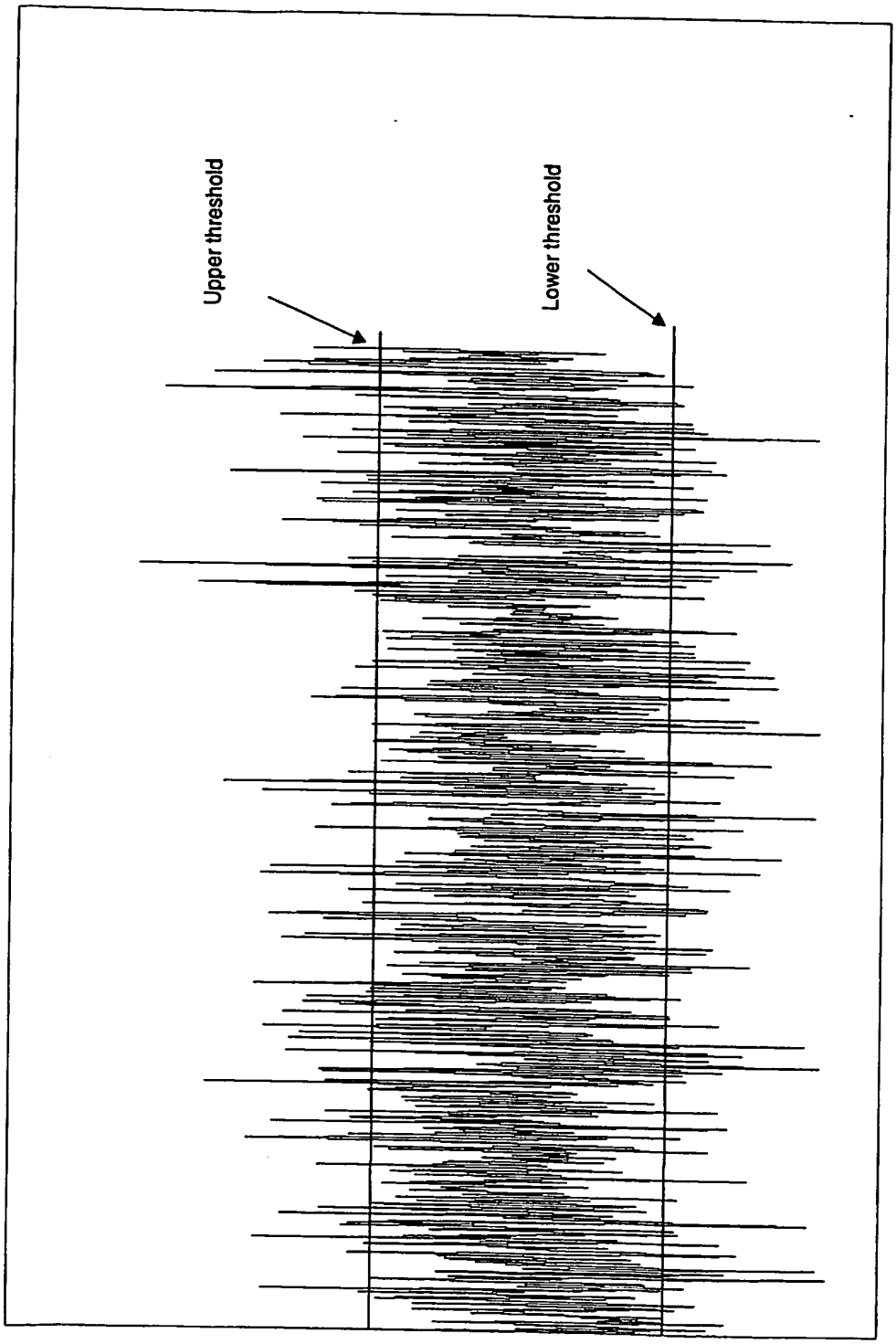
Simple Condition Monitoring uses Thresholds

Figure 5



Subtracting a signature from a reference signature

Figure 6



Thresholds for Error Signals

Figure 7

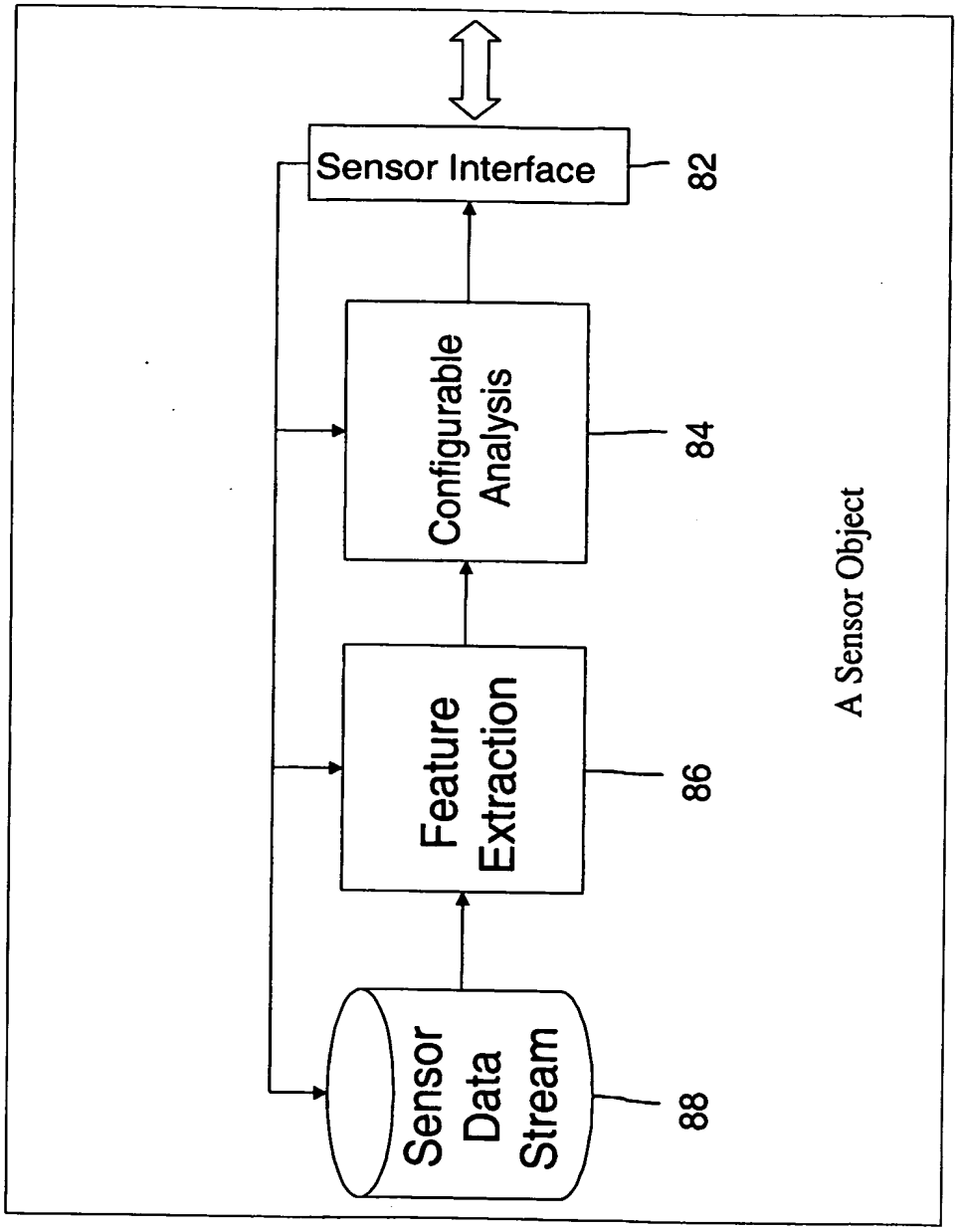

Sensor Interface
82
Configurable Analysis
84
Feature Extraction
86
Sensor Data Stream
88
A Sensor Object

Figure 8

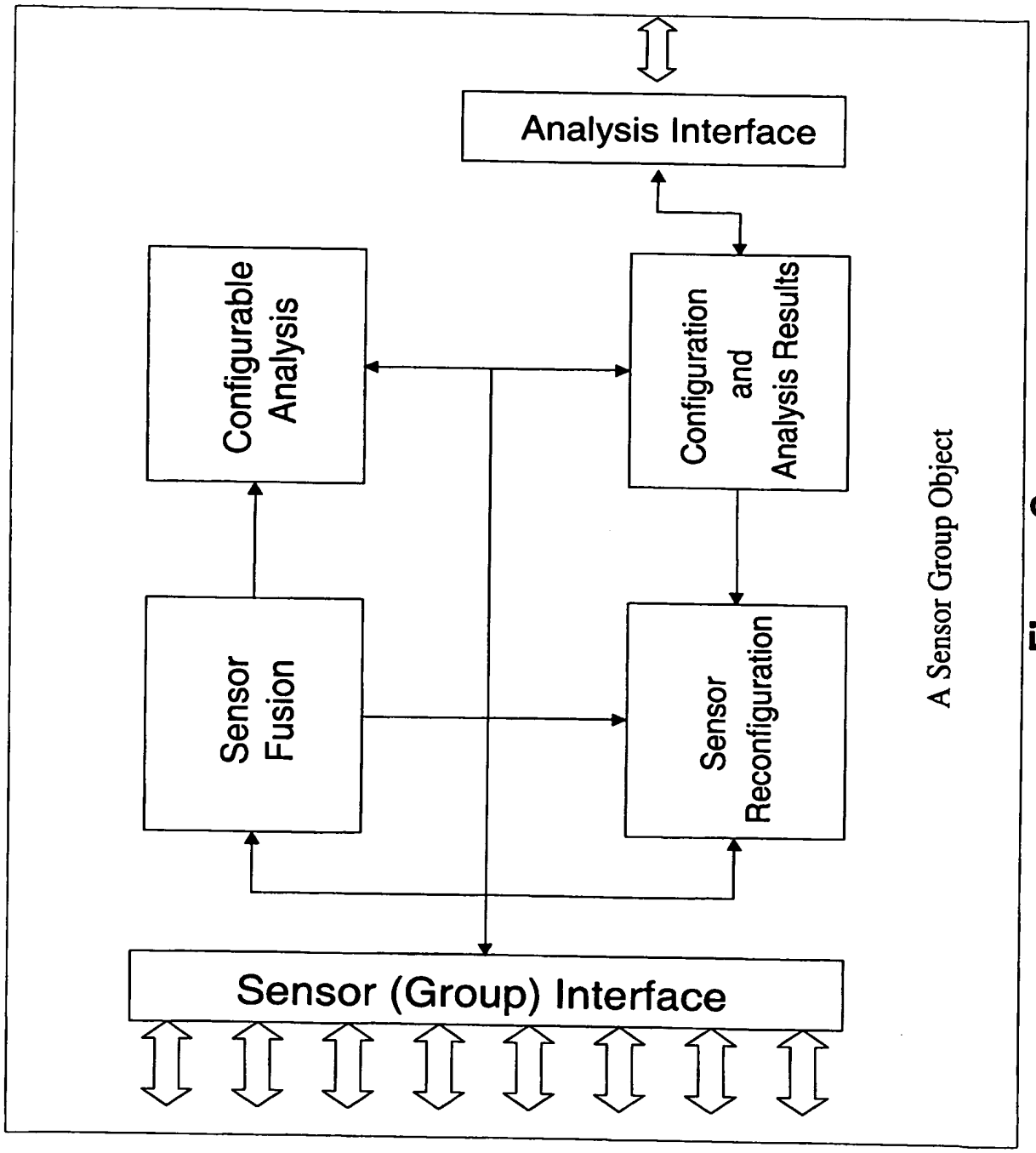

Analysis Interface
Configurable Analysis
Configuration and Analysis Results
Sensor Fusion
Sensor Reconfiguration
Sensor (Group) Interface
A Sensor Group Object

Figure 9

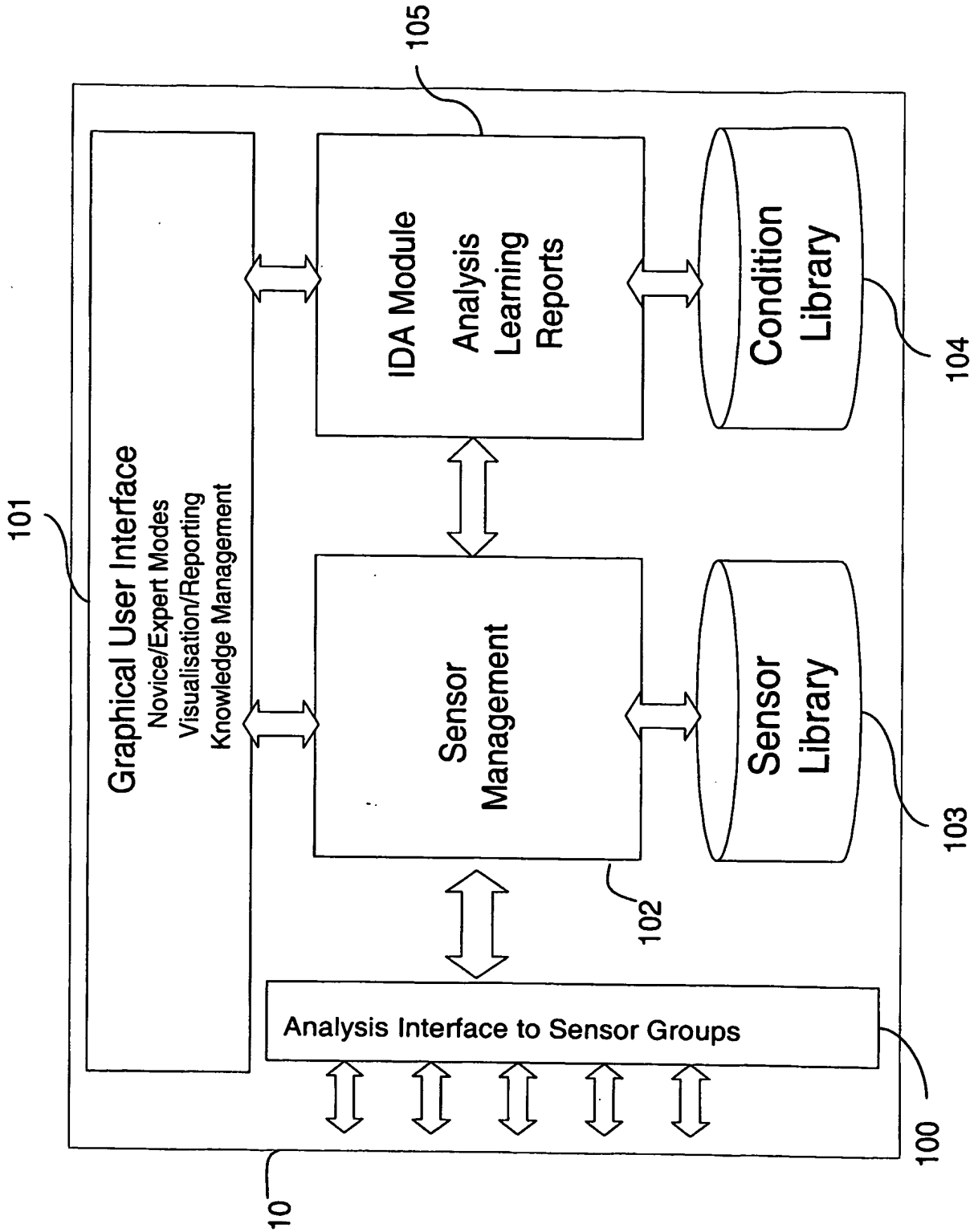

105
IDA Module
Analysis
Learning
Reports
Condition
Library
104
Graphical User Interface
Novice/Expert Modes
Visualisation/Reporting
Knowledge Management
101
Sensor
Management
Sensor
Library
103
102
Analysis Interface to Sensor Groups
100
10

Figure 10

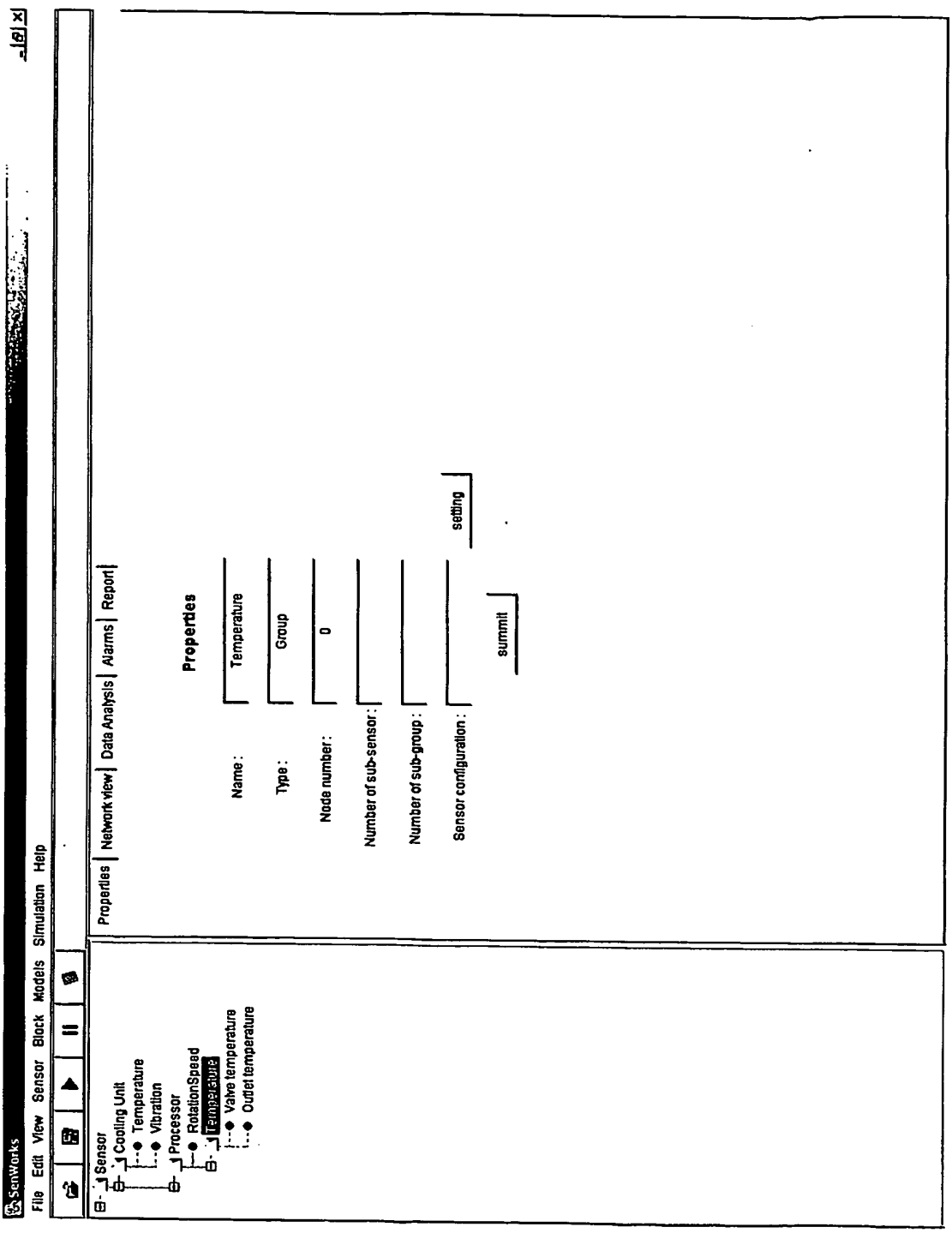

SenWorks
File Edit View Sensor Block Models Simulation Help
Sensor
Cooling Unit
Temperature
Vibration
Processor
RotationSpeed
Temperature
Valve temperature
Outlet temperature
Properties | Network view | Data Analysis | Alarms | Report
Properties
Name :
Temperature
Type :
Group
Node number :
0
Number of sub-sensor :
Number of sub-group :
Sensor configuration :
setting
summit

Figure 11

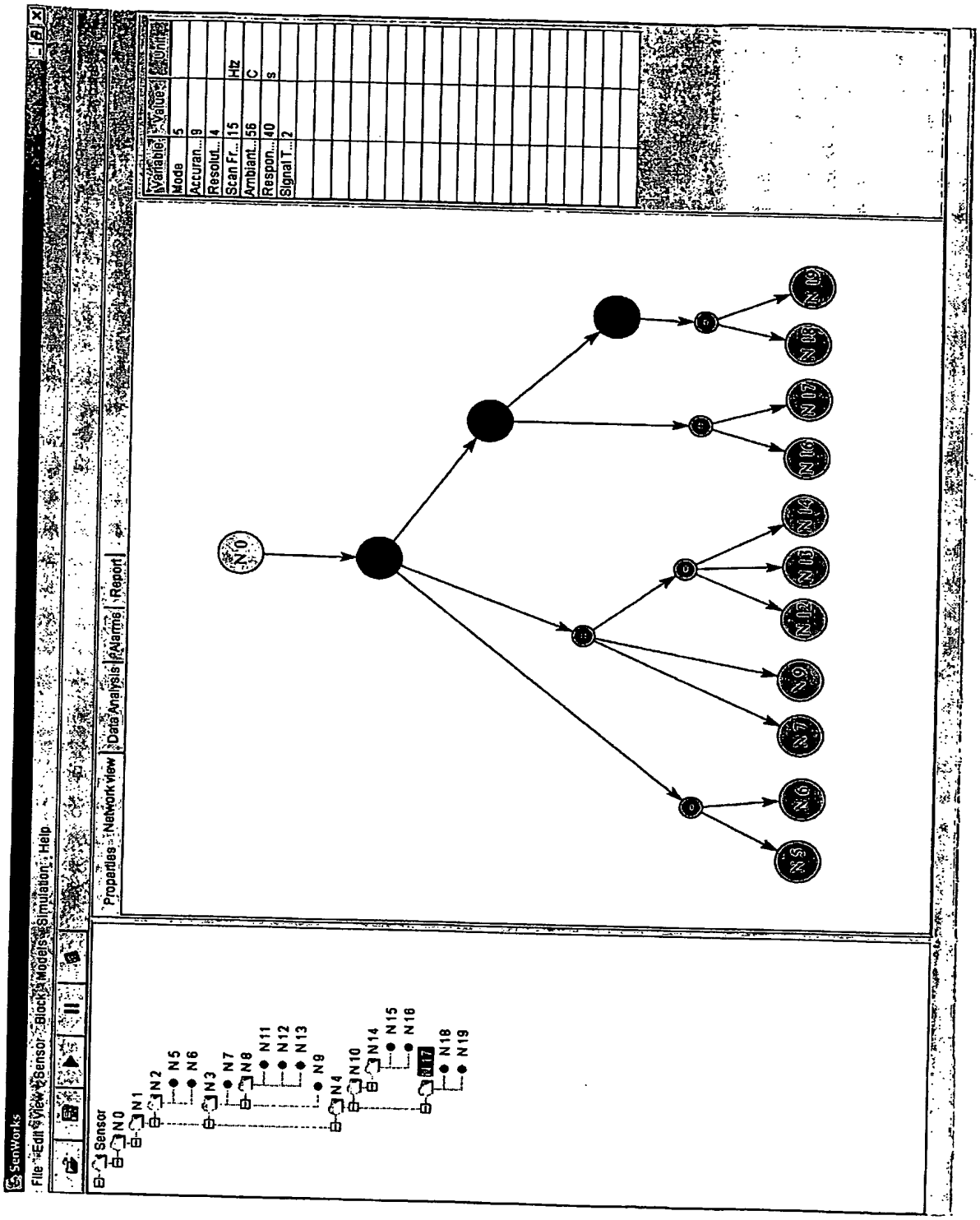

SenWorks
File Edit View Sensor Blocks Models Simulation Help
Sensor
N0
N1
N2
N3
N4
N5
N6
N7
N8
N9
N10
N11
N12
N13
N14
N15
N16
N17
N18
N19
Properties
Network view
Data Analysis
Name
Report
Variable
Value
Units
Mode 5
Accuran... 9
Resolut... 4
Scan Fr... 15 Hz
Ambient... 56 C
Respon... 40 s
Signal T... 2

Figure 12

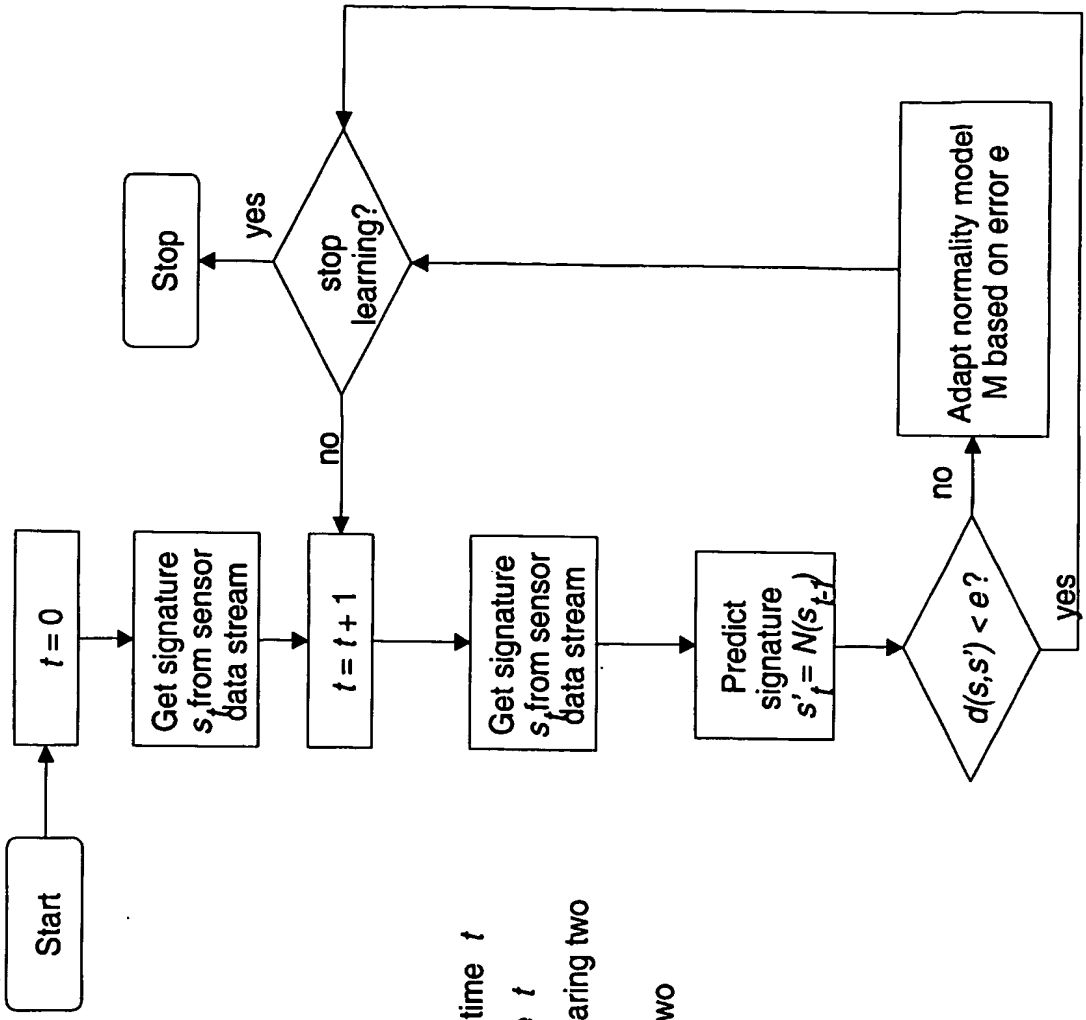

Start
t = 0
Get signature s_t from sensor data stream
t = t + 1
Get signature s_t from sensor data stream
Predict signature $s'_t = N(s_{t-1})$
$d(s,s') < e$?
no
yes
Adapt normality model M based on error e
stop learning?
yes
Stop
no
Legend
N: normality model
s_t: signature (sensor data) at time t
s'_t: predicted signature at time t
d: distance function for comparing two signatures
e: error, difference between two signatures

Figure 13

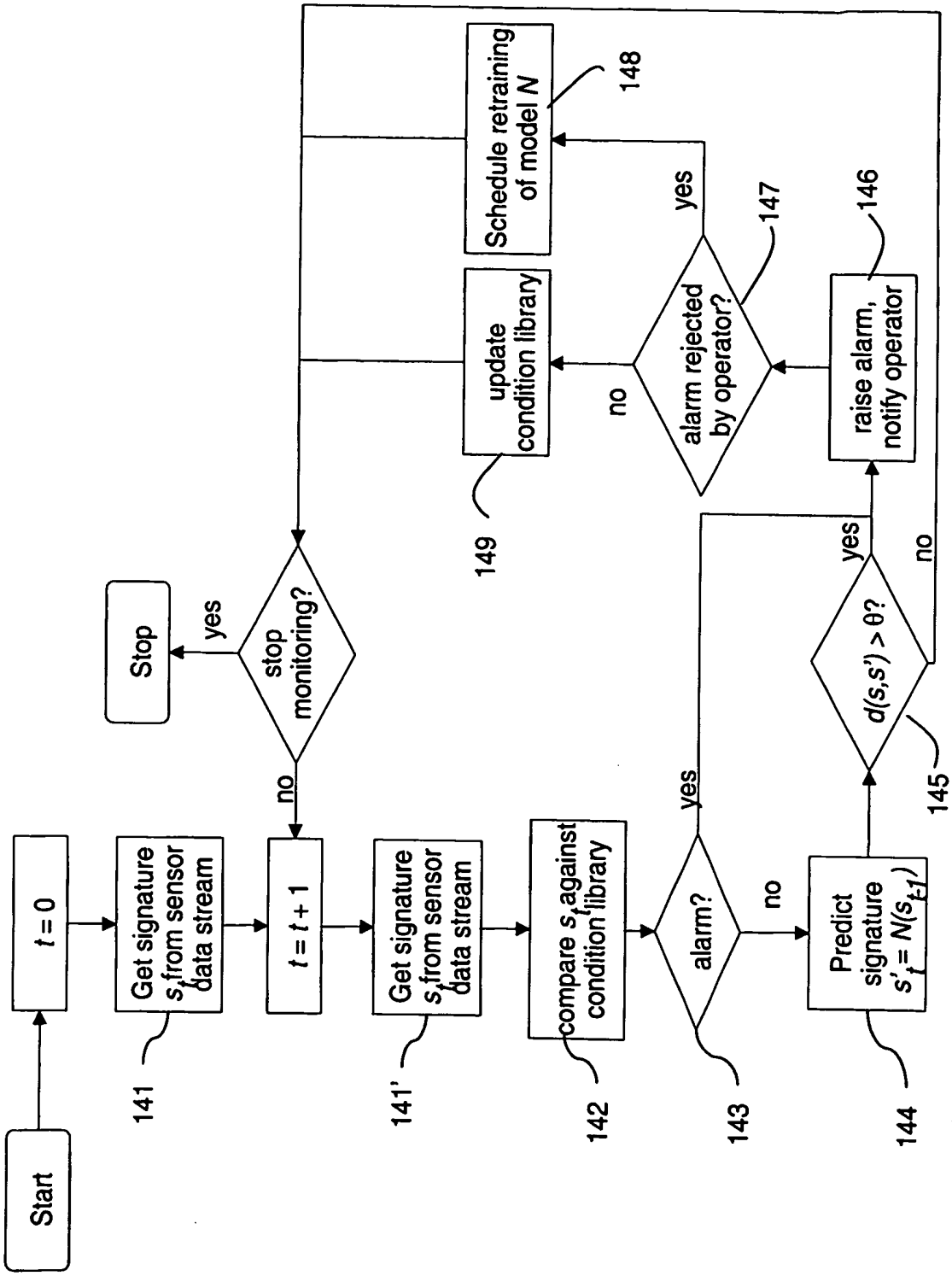

Start
t = 0
Get signature s_t from sensor data stream
141
t = t + 1
Get signature s_t from sensor data stream
141'
compare s_t against condition library
142
alarm?
143
yes
no
Predict signature $s'_t = N(s_{t-1})$
144
$d(s,s') > \theta$?
145
yes
no
raise alarm, notify operator
146
alarm rejected by operator?
147
yes
no
Schedule retraining of model N
148
update condition library
149
stop monitoring?
yes
no
Stop

Figure 14

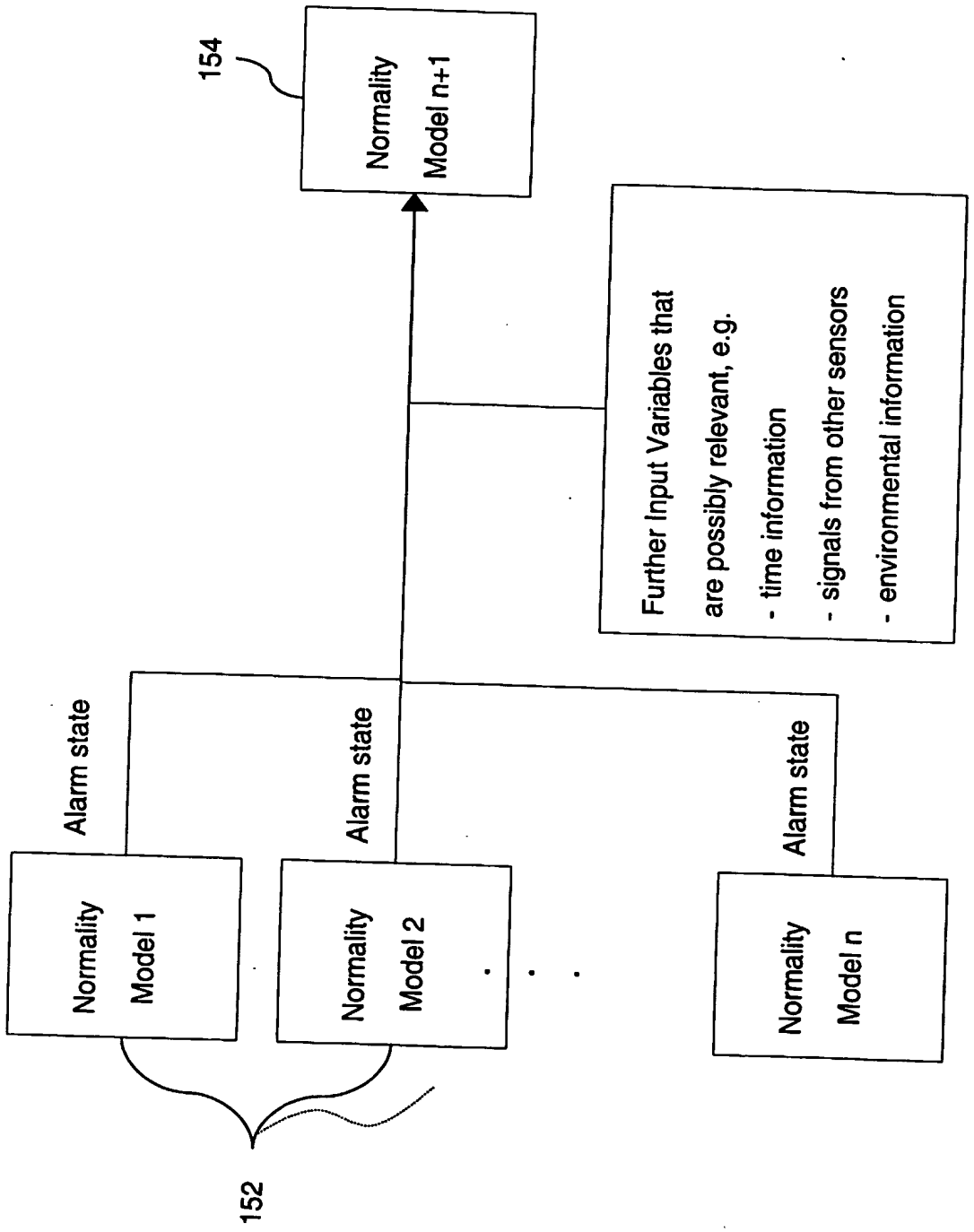

154
Normality Model n+1
Further Input Variables that are possibly relevant, e.g.
- time information
- signals from other sensors
- environmental information
Alarm state
Alarm state
Alarm state
Normality Model 1
Normality Model 2
Normality Model n
152

Figure 15